WHAT IS CLAIMED IS:

1. A method of treatment of chemical impurities in used CFC-113 fluid using a photochemical reaction, wherein the chemical impurities are molecules that have hydrogen atoms in the hydrogen-carbon bonds, and the used CFC-113 fluid and the chemical impurities form an azeotropic or pseudoazeotropic mixture, comprising the steps of:

a) placing used CFC-113 fluid containing the chemical impurities into a photochemical reactor having a process compartment;

b) placing halogen fluid into said photochemical reactor;

c) irradiating said used CFC-113 fluid and said halogen fluid using radiant energy from lamps in the visible and ultraviolet light regions of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) halogenating said hydrogen-carbon bonded molecules in said chemical impurities with said halogen fluid to form halogenated chemical impurities during a dwell time period for elimination of said azeotropic mixture; and

e) removing said halogenated impurities by physical means, wherein said physical means include the standard process techniques of physical separation.

2. A method of treatment of chemical impurities in accordance with Claim 1, further including the step of:

a) processing said used CFC-113 fluid in said photochemical reactor at an operating pressure in the range from a vacuum of 0.1 atmosphere absolute to 20 atmospheres, at an operating temperature from -100°C to +100°C and at an operating radiant energy level in the region of the electromagnetic spectrum from 240nm to 720nm, wherein said halogen fluid is chlorine (Cl_2).

3. A method of treatment of chemical impurities in accordance with Claim 1, further including the step of:

a) pumping said used CFC-113 fluid from an inventory receiver tank to said process compartment of said photochemical reactor, such that a circulation pump is used to circulate said used CFC-113 fluid between said process compartment and said receiver tank until all of said hydrogen atoms of said hydrogen-carbon bonds of said molecules in said chemical impurities are substituted by said halogen fluid within said process compartment of said photochemical reactor.

4. A method of treatment of chemical impurities in accordance with Claim 3, further including the step of:

a) reacting said impurities of the used CFC-113 fluid in said process compartment for said dwell time period is in the range of 1 hour to 100 hours, depending upon the concentration of said chemical impurities of said used CFC-113 fluid.

5. A method of treatment of chemical impurities in used chlorofluorocarbon (CFC) fluid using a photochemical reaction, wherein the chemical impurities are molecules that have hydrogen atoms in the hydrogen-carbon bonds, and the used CFC fluid and the chemical impurities form an azeotropic or pseudoazeotropic mixture, comprising the steps of:

a) placing used CFC fluid containing the chemical impurities into a photochemical reactor having a process compartment;

b) placing halogen fluid into said photochemical reactor, wherein said halogen fluid is selected from a group consisting of chlorine (Cl_2), bromine (Br_2) and iodine (I_2);

c) irradiating said used CFC fluid and said halogen gas using radiant energy from lamps in the visible and ultraviolet light regions of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) halogenating said hydrogen-carbon bonds of said molecules in said chemical impurities with a halogen gas to form halogenated chemical impurities during a dwell time period for elimination of said azeotropic mixture; and

e) removing said halogenated impurities by physical means, wherein said physical means include standard process techniques of physical separation.

6. A method of treatment of chemical impurities in used fluorocarbon (FC) fluid using a photochemical reaction, wherein the chemical impurities are molecules which contain one or more double bonds, and the used FC fluid and the chemical impurities form an azeotropic or pseudoazeotropic mixture, comprising the steps of:

a) placing used FC fluid containing the chemical impurities into a photochemical reactor having a process compartment;

b) placing halogen fluid into said photochemical reactor, wherein said halogen fluid is selected from a group consisting of chlorine (Cl_2), bromine (Br_2) and iodine (I_2);

c) irradiating said used FC fluid and said halogen fluid using radiant energy from lamps in the visible and ultraviolet light regions of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) halogenating said double bonds of said molecules in said chemical impurities with said halogen fluid to form halogenated chemical impurities during a dwell time period for elimination of said azeotropic mixture; and

e) removing said halogenated impurities by physical means, wherein said physical means include standard process techniques of physical separation.

7. A method of treatment of chemical impurities in used CFC-113 fluid using a photochemical reaction, wherein the chemical impurities are molecules which contain a hydrogen atom and a halogen atom on the same carbon of the molecule, and the used CFC-113 fluid and the chemical impurities form an azeotropic or pseudo-azeotropic mixture, comprising the steps of:

a) placing the used CFC-113 fluid containing chemical impurities into a photochemical reactor having a process compartment;

b) placing oxygen (O_2) fluid or air into said photochemical reactor;

c) irradiating said used CFC-113 fluid and said oxygen fluid or air using radiant energy from lamps in the visible and ultraviolet regions of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) reacting the hydrogen atom and halogen atom of said molecules of said chemical impurities with said oxygen (O_2) fluid or air by oxygenation to form oxidized chemical impurities during a dwell time period for the elimination of said azeotropic mixture; and

e) removing said oxidized chemical impurities from said used CFC-113 fluid by physical means, wherein said physical means include standard process techniques of physical separation.

8. A method of treatment of chemical impurities in accordance with Claim 7, further including the step of:

a) processing said used CFC-113 fluid in said photochemical reactor at an operating pressure in the range from a vacuum of 1mmHg to 20 atmospheres, at an operating temperature from -100°C to +100°C and at an operating radiant energy level in the region of the electromagnetic spectrum from 240nm to 720nm.

9. A method of treatment of chemical impurities in accordance with Claim 7, further including the step of:

a) pumping said used CFC-113 fluid from an inventory receiver tank to said process compartment of said photochemical reactor, such that a circulation pump is used to circulate said used CFC-113 fluid between said process compartment and said receiver tank until all of said hydrogen atoms and said chlorine atoms are substituted by said oxygen fluid within said process compartment of said photochemical reactor.

10. A method of treatment of chemical impurities in accordance with Claim 9, further including the step of:

a) reacting said used CFC-113 fluid in said process compartment for said dwell time period in the range of 1 hour to 100 hours, depending upon the concentration of said chemical impurities of said used CFC-113 fluid.

11. A method of treatment of chemical impurities in used chlorofluorocarbon (CFC) fluid using a photochemical reaction, wherein the chemical impurities are molecules which contain a hydrogen atom and a halogen atom on the same carbon of the molecule, and the used CFC fluid and the chemical impurities form an azeotropic or pseudoazeotropic mixture, comprising the steps of:

a) placing the used CFC fluid containing chemical impurities into a photochemical reactor having a process compartment;

b) placing oxygen (O_2) fluid or air into said photochemical reactor;

c) irradiating said used CFC fluid and said oxygen fluid or air using radiant energy from lamps in the visible and ultraviolet regions of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) reacting the hydrogen atom and halogen atom of said molecules of said chemical impurities with said oxygen (O_2) fluid or air by oxygenation to form oxidized chemical impurities during a dwell time period for the elimination of said azeotropic mixture; and

e) removing said oxidized chemical impurities from said used CFC fluid by physical means, wherein said physical means include standard process techniques of physical separation.

12. A method of treating hydrochlorofluorocarbon (HCFC) fluids using a photochemical reaction, wherein the HCFC molecules contain a hydrogen atom and a halogen atom on the same carbon of the HCFC molecule, comprising the steps of:

a) placing said HCFC fluid into a photochemical reactor having a process compartment;

b) placing oxygen (O_2) fluid or air into said photochemical reactor;

c) irradiating said HCFC fluid and said oxygen fluid or air using radiant energy from lamps in the visible and ultraviolet regions of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) reacting the hydrogen atom and halogen atom of said molecules of said HCFC fluid with said oxygen (O_2) fluid or air by oxygenation to form an acetyl fluid during a dwell time period; and

e) removing said acetyl fluid from said HCFC fluid by standard process techniques of physical separation.

13. A method of treating hydrofluorocarbon (HFC) fluids using a photochemical reactor, wherein the HFC molecules contain a hydrogen atom and a halogen atom on the same carbon of the HFC molecule, comprising the steps of:

a) placing said HFC fluid into a photochemical reactor having a process compartment;

b) placing oxygen fluid or air into said photochemical reactor;

c) irradiating said HFC fluid and said oxygen fluid or air using radiant energy from lamps in the visible and ultraviolet region of the electromagnetic spectrum to conduct thermolysis, photolysis and photochemical treatment;

d) reacting by methatesis of oxygen by substitution of an atom of hydrogen and an atom of flourine from the same carbon with oxygen fluid and thereby forming an acetyl fluid; and

e) removing said fluid acetyl by standard techniques of physical separation such as distillation and adsorption.

14. A photochemical reactor for transforming a reactant fluid by employing a photochemical reaction wherein the reactant fluid has molecules which contain hydrogen-carbon bonds which form an azeotropic or pseudoazeotropic mixture therein, comprising:

a) a photochemical reactor having a housing shell member;

b) said housing shell member having a cover member being attached thereto by a seal for forming a process compartment therein for receiving the reactant fluid therein;

c) a plurality of tube-lamp sleeves each having a tube retainer and seal member for sealing each of said tube-lamp sleeves within said cover member;

d) each of said tube-lamp sleeves for holding a UV lamp therein, said UV lamps for irradiating the reactant fluid and a halogen gas or oxygen gas, and using radiant energy from said UV lamps in the visible and ultraviolet light regions of the electromagnetic spectrum in order to conduct thermolysis, photolysis and photochemical treatment of the reactant fluid in said process compartment; and

e) said process compartment for halogenating or oxidizing the reactant fluid for a pre-determined dwell reaction period in order to transform the reactant fluid in order to produce a high-quality product.

15. A photochemical reactor in accordance with Claim 14, further including an inventory receiver tank having a circulation pump, such that said circulation pump is used to circulate the reactant fluid between said process compartment and said receiver tank until all of said hydrogen-carbon bonds are substituted by the halogen gas within said process compartment of said photochemical reactor.

16. A photochemical reactor in accordance with Claim 14, wherein said housing shell member includes an exterior wall and an interior wall in contact with each other.

17. A photochemical reactor in accordance with Claim 16, wherein said housing shell member includes heat transfer means for conducting the transfer of heat or cold on said exterior wall.

18. A photochemical reactor in accordance with Claim 17, wherein said exterior wall is made from stainless steel, steel or other suitable metal materials for conducting the transfer of heat or cold by said heat transfer means.

19. A photochemical reactor in accordance with Claim 17, wherein said heat transfer means include heating or cooling jackets on said exterior wall of said housing shell member.

20. A photochemical reactor in accordance with Claim 17, wherein said heat transfer means include heating or cooling coils on said exterior wall of said housing shell member.

21. A photochemical reactor in accordance with Claim 17, wherein said heat transfer means for conducting the transfer of heat or cold on said exterior wall has a temperature range from -100°C to +100°C.

22. A photochemical reactor in accordance with Claim 16, wherein said interior wall is made from glass quartz or fluoropolymers for allowing unreacted/inert contact with said halogen fluid and said reactant fluids.

23. A photochemical reactor in accordance with Claim 20, wherein said fluoropolymer is tetrafluoroethylene hexapropylene vinylidine (THV).

24. A photochemical reactor in accordance with Claim 14, wherein said housing shell member has a fluid loading port therein and has a fluid drain port therein for loading and unloading the reactant fluids, respectively, into and from said process compartment.

25. A photochemical reactor in accordance with Claim 14, wherein said housing shell member has an inside diameter in the range of 5cm to 100cm and an overall length in the range of 10cm to 300cm.

26. A photochemical reactor in accordance with Claim 14, wherein said cover member includes a gas receiving port for introducing a halogen fluid or other fluids into said process compartment.

27. A photochemical reactor in accordance with Claim 14, wherein said cover member includes a pressure port for pressurization of said process compartment at a operating pressure level in a range of from a vacuum of 1mm Hg to 20 atmospheres.

28. A photochemical reactor in accordance with Claim 14, wherein said halogen fluid is selected from the group consisting of chlorine (Cl_2), bromine (Br_2), and iodine (I_2).

29. A photochemical reactor in accordance with Claim 14, wherein said cover member includes one or more hole openings for receiving one or more of said tube-lamp sleeves therethrough.

30. A photochemical reactor in accordance with Claim 14, wherein said tube-lamp sleeve is formed as a quartz glass tube having a dome end, said tube-lamp sleeve having an outside diameter range of 10mm to 40mm, an inside diameter range of 8mm to 38mm, a wall thickness range of 0.5mm to 5mm, and an overall length in the range of 10cm to 300cm.

31. A photochemical reactor in accordance with Claim 14, wherein said tube retainer and seal member includes a tube sleeve ferrule assembly having a threaded male ferrule section and a threaded female ferrule section for receiving said threaded male ferrule section therein.

32. A photochemical reactor in accordance with Claim 31, wherein said male and female ferrule sections cooperate for receiving a plurality of O-rings for sealing of said tube-lamp sleeve within said cover member in order to prevent leaking of the reactant fluid and the halogen and/or oxygen fluid from said housing shell member.

33. A photochemical reactor in accordance with Claim 14, wherein said tube-lamp sleeves are arranged in a triangular pitch configuration within said housing shell member for optimizing the reaction time of the reactant fluid and the oxygen and/or halogen fluid in said process compartment.

34. A photochemical reactor in accordance with Claim 14, wherein said tube-lamp sleeves are arranged in a square pitch configuration within said housing shell member for optimizing the reaction time of the reactant fluid and the oxygen and/or halogen fluid in said process compartment.

35. A photochemical reactor in accordance with Claim 14, wherein said UV lamp operates at a radiant energy level in the electromagnetic spectrum region in the range from 240mm to 720mm.

36. A photochemical reactor in accordance with Claim 16, wherein said dwell reaction period is in the range of 1 hour to 100 hours for reacting the reactant fluid with the oxygen and/or halogen fluid in order to yield a 99.99% purity product fluid.